

REMARKS

Claims 1-4 and 29 are pending.

Claims 1-4 and 29 are rejected.

Claims 1 and 4 are amended.

Applicants request reconsideration of 1-4 and 29.

I. Indication of priority

Per the Examiner's comments, Applicants have amended paragraph [0000] (added in the Preliminary Amendment) by inserting the parent's patent number.

II. Objection to specification/claim 4

Per the Examiner's comments, Applicants have amended claim 4 and paragraph [0027] of the specification by capitalizing the term "Torr."

III. Rejection of claim under §112

The Examiner rejected claim 1 as being indefinite based on the term "sufficient." Applicants have clarified claim 1 by removing the term "sufficient."

IV. Rejection of claims under §102

The Examiner rejected claims 1-4 and 29 as being anticipated by U.S. Pat. No. 6,051,286 by Zhao et al. In attempting to support the rejection, the Examiner cited various portions of Zhao. Applicants contend, however, that the text of those citations do not support the Examiner's interpretation, thereby indicating that the Examiner has failed to meet the burden for rejecting these claims.

For example, in attempting to support the rejection of claim 1, the Examiner announced that Zhao et al. teaches contacting a substrate with a plasma of approximately 50-90% of a metal containing gas. (Office Action dated 3/7/2 at p. 3.) For support, the Examiner cited Zhao's Abstract; figure 19 references 1014 and 1015; figure 21; col. 2, ln. 17-18; col. 5, ln. 30-35; col. 6, ln. 44-46; and claims 1, 2, and 22. (Office Action dated 3/7/2 at p. 3) A careful analysis of these excerpts, however, indicates that they fail to disclose a plasma of approximately 50-90% of a metal containing gas.

Zhao's Abstract, for example, fails to go into such detail:

[t]he present invention provides systems, methods and apparatus for depositing titanium films at rates up to 200 Å/minute on semiconductor substrates from a titanium tetrachloride source. In accordance with an embodiment of the invention, a ceramic heater assembly with an integrated RF plane for bottom powered RF capability allows PECVD deposition at a temperature of at least 400° C. for more efficient plasma treatment. A thermal choke isolates the heater from its support shaft, reducing the thermal gradient across the heater to reduce the risk of breakage and improving temperature uniformity of the heater. A deposition system incorporates a flow restrictor ring and other features that allow a 15 liters/minute flow rate through the chamber with minimal backside deposition and minimized deposition on the bottom of the chamber, thereby reducing the frequency of chamber cleanings, and reducing clean time and seasoning. Deposition and clean processes are also further embodiments of the present invention.

Zhao's figure 19 is a flow chart of a process sequence. That figure's steps 1014 and 1015 specified by the Examiner merely disclose raising the substrate to a deposition height, turning on plasma, and depositing film. The text addressing those steps does not provide any additional disclosure concerning a plasma of approximately 50-90% of a metal containing gas. (See Zhao at col. 37, ln. 37-56.) In fact, that excerpt as well as others addressing Zhao's figure 19 actually disclose only the contrary of the Examiner's position. Specifically, Zhao teaches a vapor that contains metal ($TiCl_4$) and is flowed with a source gas (helium). (Zhao at col. 36, ln. 41-67.) Zhao also teaches introducing a reactant gas, such as hydrogen, which lowers the energy required to decompose the source gas. (*Id.* at ln. 21-24.) Moreover, Zhao teaches that the initial reactant

gas/source gas flow ratio can be almost 250:1. (See *id.* at 42-43.) Thus, because the source gas flow rate can be almost 250 times less than the reactant gas flow rate; and the source gas flow rate is associated with the introduction of the vapor containing the metal, it follows that the contribution of the vapor containing metal is far from 50-90%, plasma or no. Furthermore, Zhao teaches increasing the reactant gas flow rate just before establishing a plasma (*id.* at col. 37, ln. 37-38) and indicates that such an increase reduces the quantity of $TiCl_4$ delivered to the chamber (*id.* at ln. 9-12). Hence, once a plasma is established, Zhao teaches lowering even further the contribution of the vapor containing metal. Thus the text supporting the very figure relied upon by the Examiner refutes the Examiner's proposition and in fact discloses only the exact opposite.

As for the Examiner's citation to Zhao's figure 21, that graph merely illustrates the relationship between deposition rate and the ratio of $TiCl_4$ vapor pressure to the total pressure ($TiCl_4 + He$) over the liquid source of $TiCl_4$. (Zhao at col. col. 39, ln. 42-48.) This graph does not address $TiCl_4$'s contribution to the plasma and accordingly fails to disclose a plasma of approximately 50 to 90 % of a metal-containing gas.

Regarding the Examiner's citation to Zhao's col. 2, ln. 17-18, that excerpt is merely a portion of a sentence that refers to target atoms condensing into a thin film on the substrate, which is on the substrate holder. Again, there is no mention of a plasma of approximately 50-90% of a metal containing gas.

Concerning the Examiner's citation to Zhao's col. 5, ln. 30-35, that excerpt is only a truncated sentence introducing the summary of Zhao's invention and fails to address a plasma of approximately 50-90% of a metal containing gas:

SUMMARY OF THE INVENTION

The present invention provides systems, methods, and apparatus for high temperature (at least about 400° C.) processing of substrates in a plasma-enhanced chemical vapor deposition (PECVD) chamber. Embodiments of the present invention include a PECVD system for depositing a

The Examiner's citation to col. 6, ln. 44-46 repeats the disclosure that the reactant gas/source gas (including a metal) flow ratio can be almost 250:1. (Compare Zhao at col. 6, ln. 44-46 with col. 36, ln. 42-50 (discussed above).) While the cited text allows for a smaller ratio, Applicants

contend that Zhao's emphasis of a reactant gas flow rate that may be hundreds of times greater than the source gas cannot be interpreted to disclose a metal containing gas contributing to approximately 50-90% of a plasma.

As for the Examiner's citation to claim 1, that claim is silent concerning the % contribution of the plasma's constituents:

1. A process for depositing a layer on a substrate on a heater in a chamber, said process comprising the steps of:

heating said heater; A [sic]
pressurizing said chamber;
introducing a reactant gas and a source gas into said chamber, said source gas comprising a metal and a halogen
applying RF energy to form a plasma adjacent to the substrate; and ramping the flow of said reactant gas, said source gas, and a plasma gas, to avoid thermally shocking said heater.

As for the Examiner's reliance on Zhao's claim 2, that claim specifies a reactant-sources gas flow ratio that may be almost 100:1 as part of introducing the gases. Similar to excerpts from col. 6, ln. 44-46 and col. 36, ln. 42-50 discussed above, while claim 2 allows for a smaller flow ratio, Zhao's emphasis of a reactant gas flow rate that may be a hundred times greater than the source gas cannot be interpreted to disclose a metal containing gas contributing to approximately 50-90% of a plasma.

The Examiner's citation to Zhao's claim 22 is even more unfavorable in terms of supporting the Examiner's assumption about a plasma of approximately 50-90% of a metal containing gas. Specifically, claim 22 teaches a reactant gas flow rate that is about 20 to 50 times greater than the flow rate of the source gas, which contains a metal. Applicants contend that in no way can such disclosure be interpreted as disclosing a plasma of approximately 50-90% of a metal containing gas.

Thus, none of the Examiner's citations support the Examiner's contention that Zhao discloses a metal containing gas contributing to approximately 50-90% of a plasma. In fact, there are many excerpts in Zhao which disclose only the opposite. As a result, the Examiner has failed to meet the burden for rejecting claim 1. Moreover, the Examiner's contention forms part of the basis for rejecting dependent claims 2-4 as well. Accordingly, the Examiner has failed to meet the burden for rejecting those claims as well.

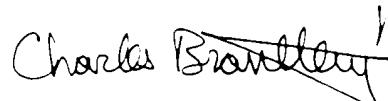
Similarly, in attempting to support the rejection of claim 29, the Examiner announced that Zhao et al. teaches contacting a surface with a plasma of approximately 50-90% metal-containing compound. (Office Action dated 3/7/2 at p. 4) Significantly, the Examiner cited the same excerpts addressed above. Accordingly, Applicants contend that the analysis presented above supports a similar conclusion -- none of the Examiner's citations support the Examiner contention that Zhao discloses a metal containing compound contributing to approximately 50-90% of a plasma. In fact, there are many excerpts in Zhao which disclose only the opposite. As a result, the Examiner has failed to meet the burden for rejecting claim 29 as well.

Applicants also note that Applicants' claims 1-4 require a plasma of approximately 50 to 90 % of a metal-containing gas, and claim 29 requires a plasma of approximately 50 to 90 % of a metal-containing compound. Hence, the same analysis demonstrating the Examiner's errors in reasoning also demonstrate that the burden for rejection *cannot* be met relying on Zhao given that its disclosure is either silent or directly contrary to at least one limitation present in the claims.

CONCLUSION

In light of the above amendments and remarks, Applicants submit that claims 1-4 and 29 are allowable over the applied reference. Therefore, Applicants respectfully request reconsideration of the Examiner's objections and rejections and further requests allowance of all of the pending claims. If there are any matters which may be resolved or clarified through a telephone interview, the Examiner is requested to contact Applicants' undersigned attorney at the number indicated.

Respectfully submitted,



Date: 6/5/2

Charles B. Brantley II
Reg. No. 38,086
Micron Technology, Inc.

8000 S. Federal Way
Boise, ID 83716-9632
(208) 368-4557
ATTORNEY FOR APPLICANTS

Appendix 1: Marked version of amended Specification paragraphs

[0000] This application is a continuation of application serial number 09/249,478, filed Feb. [ruary] 12, 1999 and issued as U.S. Pat. No. 6,291,341.

[0027] For the purposes of describing one particular embodiment of the invention, it is assumed that a deposition process is to be carried out within the PECVD system 10 described in Figure 1. More specifically, it is assumed that titanium is being deposited from the reaction of titanium tetrachloride (TiCl₄) and hydrogen. Process parameters include a temperature of about 150 to about 500 degrees Celsius; a pressure ranging from about 1 milli-Torr to about 10 Torr; an RF power ranging from about 50 watts to about 600 watts, preferably 500 watts, and at a frequency on the order of 13.56 MHz. The flow rate of the precursor gas TiCl₄ generally ranges between about 10 and about 50 sccm, but is preferably about 30 sccm, and the flow rate of the reactant gas H₂ is about 10,000 sccm. In addition, an inert reaction-promoter gas is flowed into the system 10. It is preferred that the flow rate percentage of reaction-promoter gas to reactant gas be at least 40%. In the current example, the reaction-promoter gas is flowed at a rate of about 5,000 sccm. Nevertheless, a flow rate of at least 4,000 sccm would be acceptable.

Appendix 2: Marked version of amended claims.

1. (Twice amended) A process of PECVD deposition of metal films comprising the steps of:
 - providing an ion promoting atmosphere; and
 - contacting a substrate with a plasma of approximately 50 to 90 % of a metal-containing gas in said ion promoting atmosphere[at a pressure and temperature range sufficient for film deposition for said metal].

4. (Once amended) The process of claim 1 wherein said step of contacting a substrate with a plasma comprises having a pressure range of 1 mT[t]orr to 10 T[t]orr.